

# Geotechnical Report Guidelines

---

The City may require a geotechnical investigation and report based on the nature of the proposal. The reporting requirements for single-family permits may be waived, if a report for the site meeting the City of Shoreline's criteria has been filed less than five years before the date of application and the Geotechnical Engineer who signed the report prepares a written letter stating the report is still applicable to the site and currently proposed project.

*The Geotechnical Engineer determines the actual scope of investigation, analysis and reporting necessary to meet the Standard of Practice with respect to the project and its geotechnical requirements.* The report must be stamped, signed and dated by an engineer licensed by Washington State.

The attached report outline describes the contents for the elements in a geotechnical report. The report submitted to the City must address each element in the outline.

The content under each element will depend on the complexity of the project and site conditions. For example, a single family residence on a glacial till site without groundwater issues warrants a short, simple report; while a high-rise structure with a deep excavation on an alluvial site warrants a longer, more detailed report. The report should state "Not applicable" for each outline element that does not apply.

**GEOTECHNICAL ENGINEER** - means a practicing geotechnical/civil engineer licensed as a professional civil engineer by the State of Washington who has at least four years of professional employment as a geotechnical engineer.

**GEOTECHNICAL ENGINEERING** - means the application of soil mechanics in the investigation, evaluation, and design of civil works involving the use of earth materials and the inspection or testing of the construction thereof.

## **1.0 SUMMARY**

The summary presents the major conclusions of the investigation and their bases. This section should be included in all lengthy or complex reports.

## **2.0 INTRODUCTION**

The introduction sets the stage for the entire report and contains the following sections:

### **2.1 OVERVIEW**

- Introduce the formal project name, address and parcel numbers.
- Describe briefly the current or previous work used to form the basis for the conclusions and recommendations contained in the report.

### **2.2 BACKGROUND**

- Describe the project's history when relevant to the reason for the investigation.
- List other reports completed for the site or adjacent sites and note whether any environmental site assessments or other environmental work has been completed.
- Describe the scope of work, including grading, retaining walls, structures, construction materials and utilities. Include dimensions, quantities, proposed finish floor elevations, maximum depth of cut or fill, foundation and floor loads, etc.
- Describe all assumptions that were relied upon to develop the conclusions and recommendations contained in the report.

### **2.3 PURPOSE AND SCOPE OF SERVICES**

- State succinctly the primary purpose for the geotechnical engineering services.
- Summarize the scope of geotechnical engineering services that form the basis for the conclusions and recommendations contained in the report.
- Indicate any limitations to the scope of geotechnical engineering services provided, particularly if the scope represents a departure from service typically provided on similar projects.

### **2.4 INVESTIGATIONS SUMMARY**

- Provide the dates, general nature and extent of the geotechnical investigation. This section should include data research, borings, test pits, geophysics, physical laboratory testing, chemical testing, field instrumentation or testing, etc.
- If the investigation was complex, present a complete and detailed explanation and results in the form of an appendix.

### **2.5 REPORT OVERVIEW**

- Introduce and describe other sections of the report, directing the reader to critical sections, if appropriate.
- Identify and describe all attachments and appendices.

## **3.0 SITE CONDITIONS**

Describe all site features relevant to the study and the geotechnical engineering conclusions and recommendations. Terminology should be clear and consistent through the entire report.

### **3.1 LOCATION AND SURFACE CONDITIONS**

- Provide the cross streets, addresses and parcel numbers in order to locate the site.
- Describe the site and adjoining properties, including surface elevation, topography and drainage.
- Provide current uses of the site and adjacent properties.
- Identify all current structures, subsurface utilities, wells, manmade fills and other surface features.
- Describe vegetation, topsoil, paving and other surface coverings.
- Describe any indications of historic geological processes or hazards on or near the site (e.g., slope instability, landslides, liquefaction, flooding, etc.)

- Describe any indications of surface releases or other contamination or potential contamination sources.
- Describe any planned changes to the surface conditions described above which will take place after the investigation.

### **3.2 GEOLOGICAL SETTING**

- Provide an overview of regional geology, local stratigraphy, groundwater occurrence, etc.

### **3.3 SUBSURFACE SOIL CONDITIONS**

- Describe each soil or geologic unit encountered by their classifications and group units with respect to the properties that are most relevant to the conclusions and recommendations. Give each unit group a unique, clear, common title and consistently refer to this unit by its given title throughout the report.
- Provide important results of the laboratory physical property testing and its indications of soil behavior.
- Provide design infiltration rate per 2005 Department of Ecology Surface water Design manual for western Washington: Approved method in Volume III Appendix III-D of the Stormwater Manual.
- Avoid detailed descriptions of the sequence of units found in individual borings; rather, focus on variations in the units across the site, if appropriate. Refer the reader to the exploration logs for details.
- Describe any expected changes in subsurface conditions that may occur with time after the investigation.

### **3.4 GROUNDWATER CONDITIONS**

- Describe the nature and occurrence of groundwater.
- Provide an opinion on likely seasonal variations in groundwater levels or flows, and the possibility for changes from those encountered at the time of exploration.
- Show groundwater levels on soil logs.

### **3.5 SUBSURFACE CONTAMINATION**

- Describe the nature and extent of soil and/or groundwater contamination as revealed by the explorations. Reference any applicable Environmental Assessments if performed.
- Provide important results of the analytical laboratory testing and indications about contamination distribution and concentration.
- Indicate limitations of knowledge on the nature and extent of contamination.
- Discuss possible changes that may occur in these conditions over time.

## **4.0 DISCUSSION AND CONCLUSIONS**

The Discussion and Conclusions should set out major geotechnical issues and alternatives for the project, along with the Geotechnical Engineer's conclusions, in a succinct and clear manner. This section shall clearly describe the logic and reasoning supporting the recommended approach, or alternative approaches. Specific recommendations should be presented in the Recommendations section.

Discussions and Conclusions should:

- Build on information described in the previous sections.
- Describe project features, soils and construction materials using consistent terminology.
- Explain any apparent inconsistencies in the data or investigations.
- Describe clearly any limitations or restrictions to the conclusions and recommendations.

### **4.1 SLOPE STABILITY**

- Summarize data and analysis used to evaluate slope stability.
- Provide an opinion regarding the risk of instability on the site or adjacent properties currently, during construction, and after the project is completed.

- Describe how design and construction recommendations will reduce or eliminate the risk of stability.
- Discuss any construction or post-construction measures necessary to verify slope stability.

#### **4.2 SEISMIC CONSIDERATIONS**

- Provide an opinion on the expected level of ground motion during a major earthquake.
- Describe any seismic risks associated with an earthquake such as liquefaction, lateral spreading, landslides, or flooding.
- Describe how design and construction recommendations will reduce or eliminate the impact of seismic risks.

#### **4.3 SITE WORK**

- Describe proposed site grading and earthwork and provide an opinion on the proper sequence and approach to accomplish the site work.
- Describe key issues which will impact earthwork, including short-term slope stability, onsite and import fill materials, groundwater and drainage, rainfall and moisture sensitive soils, and erosion.
- Describe how these key issues should be addressed during construction, including dewatering, temporary retaining structures and erosion control.
- Include specific recommendations for on-site erosion control based on soil erodability and the presence of groundwater, surface water and slopes
- Include statements regarding the importance of construction monitoring by a geotechnical engineering firm.

#### **4.4 RETAINING STRUCTURES**

- Recommend appropriate temporary retaining systems.
- Recommend the most appropriate permanent retaining system or systems and describe their expected performance with respect to stability and deflection.
- Summarize the data and analysis used to evaluate permanent retaining systems.
- Clearly define all limitations on backfill materials, reinforcement, and drainage for reinforced soil slopes and reinforced soil backfill.
- Describe the limitations on such systems.
- Emphasize any aspects of site work, particularly with respect to the native soil materials, backfill and drainage, which could impact performance of the retaining structures.
- Include statements regarding the importance of construction monitoring by a geotechnical engineering firm.

#### **4.5 ROCKERIES**

- Emphasize that rockeries usually protect a slope face from erosion. Indicate which rockeries will protect the slope face by preventing soil erosion and sloughing.
- Include the design criteria for rockeries that serve as retaining structures. Indicate which rockeries will function as retaining structures.
- Recommend locations for rockeries such that a contractor can reach them for maintenance and repair.
- Discuss what type of inspection and testing may be required during rock wall construction.

#### **4.6 FOUNDATION SUPPORT**

- Summarize the data and analysis used to evaluate foundation systems.
- Provide an opinion on the most appropriate foundation system and possible alternatives, along with the expected level of performance with respect to load capacity and settlement.
- Emphasize any aspects of site work that could impact the performance of foundations.
- Include statements regarding the importance of construction monitoring by a geotechnical engineering firm.

## **5.0 RECOMMENDATIONS**

The Recommendations should present all detailed geotechnical engineering recommendations for design and construction in a clear and logical sequence.

For each item covered in the recommendations sections, present the following:

- Specific design recommendations along with their limitations, factors of safety, minimum dimensions and effect
- of expected variations in actual conditions.
- Specific construction recommendations including definitions, materials, execution, monitoring testing, or other quality control measures and any other construction requirements to support the design recommendations
- Responsibility for seeing that each recommendation is met, such as owner, geotechnical engineer or other design consultant or contractor.

### **5.1 SITE GRADING AND EARTHWORK**

- Provide specific design recommendations for: 1) depth of stripping, 2) soil excavation limits and slopes, 3) depth and lateral limits of over-excavation to remove unsuitable materials, 4) preload fills, 5) location and thickness of particular fill material or compaction requirements, 6) maximum temporary and permanent slopes, 7) permanent surface and subsurface drainage systems, and 8) permanent erosion controls.
- Provide specific construction recommendations for: 1) clearing, 2) onsite and/or import fill materials, 3) excavation and compaction equipment, 4) fill material moisture conditioning, placement, and compaction, 5) proof-rolling, in-place density testing and other quality control measures, 6) temporary seepage and drainage control measures, 7) permanent surface of subsurface drainage system installation (as appropriate), and 8) temporary slope protection and erosion control measures.
- All design and construction methodologies should be specific and identifiable; generalized or vague statements are NOT acceptable.

### **5.2 TEMPORARY SHORING AND RETAINING WALLS**

- Provide specific design recommendations for: 1) active and passive earth pressures, 2) surcharge pressures, 3) bearing capacity, 4) minimum or maximum dimensions and depth of penetration, 5) lateral support, 6) wall or backfill drainage systems, and 7) any other appropriate structured details.
- If appropriate, provide specific design recommendations for tie-back anchors including: 1) anchor inclination, 2) no load zones, 3) minimum anchor length, 4) anchor bond zone, 5) anchor adhesions, and 6) corrosion protection.
- Provide specific construction recommendations for: 1) installation, 2) onsite and/or import backfill materials, 3) backfill material moisture conditioning, placement, and compaction, 4) in-place density testing or other control measures, and 5) seepage and drainage control.
- If appropriate, provide construction recommendations for tie-back anchors including: 1) anchor installation methods, 2) anchor testing, and 3) monitoring.

### **5.3 ROCKERIES**

- Provide recommendations as outlined in the Associated Rockery Contractors (ARC) Standard Rock
- Wall Construction Guidelines (December 1992).
- The geotechnical engineer shall provide direct input to the design of the rockeries and provide construction monitoring and testing as appropriate. Specific design parameters may include: Rock
- quality, density, frequency of testing, slopes, keyways, surcharges, drainage, rock sizes, face inclination and surface drainage.

### **5.4 REINFORCED SOIL STRUCTURES**

- Geogrid or geotextile fabric may be used to reinforce a fill. If reinforced slopes are used, the geotechnical engineer shall specify, at a minimum, the fill soil materials, vertical spacing of the reinforcement, the specific type of reinforcement and the distance to which it must extend into the

fill, the amount of overlap at the reinforcement joints, and the construction sequence. Additional design parameters will be required for each specific site.

## **5.5 STRUCTURE AND FOUNDATIONS**

- Provide seismic design recommendations for: 1) Building Code soil type and site coefficients, and 2) any specific recommendations to reduce the risk of damage due to earthquakes.
- Spread footing foundations – provide design recommendations for: 1) bearing soils, 2) bearing capacity, 3) minimum footing depths and widths for both interior and exterior footings, 4) lateral load resistance, 5) foundation drainage systems, and 6) frost protection.
- Mat foundations – provide design recommendations for: 1) bearing soils, 2) bearing capacity, 3) modulus of subgrade reaction, 4) minimum dimensions, and 5) lateral load resistance.
- Pile foundations – provide design recommendations for: 1) type of pile, 2) means of support (end of friction), 3) minimum dimensions and depths, 4) allowable vertical and uplift capacity, 5) allowable lateral loads and deflections, and 6) group effects and minimum spacing.
- Spread footing or mat foundations – provide construction recommendations for: 1) foundation subgrade preparation and protection, 2) verification of bearing capacity, and 3) installation of foundation drainage system.
- Pile foundations – provide construction recommendations for: 1) pile driving equipment, 2) pile installation, 3) pile load tests or verification piles, and 4) monitoring and testing during pile installation.

## **5.6 FLOORS**

- Slab-on-Grade Floors – provide design recommendations for 1) slab base rock thickness, 2) capillary break, 3) vapor barrier, and 4) floor system drainage.
- Supported Wood Floors – provide design recommendations for: 1) vapor barrier and 2) crawl space drainage.
- Slab-On-Grade Floors – provide construction recommendations for: 1) subgrade preparation, 2) slab base rock placement and compaction, 3) capillary break and vapor barrier installation, and 4) floor drainage system installation (when appropriate).

## **5.7 PAVEMENTS**

- Provide design recommendations for 1) pavement design section and 2) pavement drainage.
- Provide construction recommendations for 1) pavement subgrade preparation and verification, and 2) pavement base and subbase materials, placement and compaction.

## **5.8 UTILITIES**

- Provide construction recommendations for 1) utility excavation, 2) bedding material placement and 3) backfill material, placement and compaction.

## **5.9 DRAINAGE**

- Recommend provisions for subsurface drainage at walls, floors and footings.
- Evaluate permanent and temporary surface and subsurface drainage for both walls and floors if applicable. Provide approximate flow rates in gallons per minute and pipe sizes if required by design.
- Provide design and recommendation for infiltration facilities, including setbacks from steep slopes per the adopted Stormwater Manual.

## **5.10 HAZARDS**

- A. Present additional information if natural or man-made hazards exist on the property. The City's Critical Areas maps identify hazards such as wetlands, streams and flood hazards, erosion, and steep slopes. Recommendations should be general and further studies may be required.

## **6.0 FIGURES AND ILLUSTRATIONS**

### **6.1 VICINITY MAP**

Include a Vicinity or Location Map that presents adequate street and/or other physical references to allow clear identification of the project location. This map may be an individual figure or may be included on the Site Plan.

### **6.2 SITE PLAN**

Show the project boundaries, property lines, existing features and the proposed development and structures. A north arrow and scale should be included along with all subsurface exploration locations. The accuracy of exploration locations should be indicated on the Site Plan or in the report.

### **6.3 EXPLORATION LOGS**

Include logs of all explorations describing soil units encountered, soil classification, density or stiffness, moisture conditions, groundwater levels, stratigraphic sequence, common geologic unit name, and other descriptive information.

### **6.4 LABORATORY TEST DATA**

Include figures or tables of laboratory test results if presentation of all the data, in the text, would require more than a simple paragraph to supplement the data provided in the exploration logs.

### **6.5 CROSS SECTIONS**

Include cross sections to visually present all but the simplest subsurface conditions.

### **6.6 TYPICAL DETAILS**

Include figures, graphs and other visual aids to clearly present detailed recommendations. Provide design details (stamped by a professional engineer licensed in Washington State) on drawings such as: rockeries, reinforced earth, interceptor trenches, wall and footing drains, utility backfill and other details used for a particular design.

## **7.0 STANDARDS FOR SLOPE STABILITY ANALYSES**

### **7.1 STUDY REQUIREMENTS**

- The geotechnical engineer should review and evaluate the stability of natural, temporary and permanently constructed slopes on or adjacent to the property to be developed. Such review should, at a minimum, include:
  - a. Review of published geologic data referencing or including the site
  - b. Review of previous studies of the site performed by geotechnical engineers.
  - c. Reconnaissance of the site for signs of slope instability.
- Where such review indicates that the proposed development would reduce slope stability, or that the natural slopes may have a factor of safety of less than 2.0 (static case) or 1.5 (seismic case), then the geotechnical engineer shall perform additional, more detailed review and evaluation of the stability of the slope. Such additional review and evaluation should, at a minimum, include:
  - a. Drilling and sampling of test borings to a depth necessary for the evaluation of slip surfaces with factors of safety lower than the above criteria, or to at least 15 feet or 10 percent of the slope height (whichever is less) beyond the most critical slip surface for the design.
  - b. Laboratory shear testing of soil samples which are representative of all significant zones or layers of soil and/or rock through which the potential slip surfaces pass.
  - c. Performing a limit equilibrium analysis or other approved analysis of all significant critical slip surfaces associated with the slope. Analyses may be conducted by a computer program if the methodology and assumptions are clearly delineated and the name, version number and solution methodology of the program are clearly presented in the report. All analyses should include a cross section of the slope(s) and critical slip surfaces.
- Other analyses as required by the City.

## 7.2 DESIGN REQUIREMENTS

For a limit equilibrium analysis, design factors for safety of slopes will be no less than the following:

Temporary Slope		Permanent Slope		
		Low Threat Upon Failure <sup>1</sup>		High Threat Upon Failure <sup>2</sup>
Static	1.25		1.40	1.50
Seismic (dynamic)	1.05	1.10	1.15	

The analysis should consider the impacts of the groundwater in the modeling of soil strength and density parameters and in other ways considered appropriate by the engineer. A conservative wet season analysis should be used for permanent slopes and those temporary slopes which will be constructed anytime between October 1 and May 31.

Alternative analyses may be proposed by the geotechnical engineer and accepted by the City, if they are based upon accepted and published methodologies which evaluate static and dynamic loading cases, and the consequences of the type of slope failure under consideration. Other design requirements remain the same.

<sup>1</sup> Permanent slopes termed “Low Threat upon Failure” are those slopes whose failure will not impact buildings or other structures uninhabited by humans.

<sup>2</sup> Permanent slopes termed “High Threat Upon Failure” are those slopes whose failure will impact or have a reasonable engineering probability of impacting buildings or other structures inhabited by humans